Sensitivity of the ratio leaf chlorophyll to leaf flavonols measured with optical sensors to crop N status of melon

Peña, M.T.[a], Thompson, R.B.[a], Gallardo, M.[a], Gimenez, C.[b]
[a]University of Almeria, Department of Crop Production, Almeria, Spain
[b]University of Cordoba, Department of Agronomy, Cordoba, Spain

1. Background & Objectives

Optical sensors are a promising approach to assess crop N status (Cartelat et al., 2005; Samborski et al., 2009). Their use *in situ* and in real time provides the potential for N fertiliser application to be rapidly adjusted to crop N status (Samborski et al., 2009). Such corrective management would be well-suited where the combined use of high frequency, drip irrigation and fertigation enables precise N application, such as in greenhouse-based vegetable production on the south-eastern (SE) Mediterranean coast of Spain. The SPAD meter estimates leaf chlorophyll content (Samborski et al., 2009). The content of leaf flavonols was reported to be an indicator of crop N status (Cartelat et al., 2005) who suggested that the ratio of leaf chlorophyll to leaf flavonols was particularly sensitive to crop N status. The current study examined the use of the ratio of leaf chlorophyll to leaf flavonols, both estimated with hand-held optical sensors, to assess crop N status of a melon crop.

2. Materials & Methods

A cantaloupe type melon crop was grown in a loam soil in a greenhouse with polyethylene cladding in Almeria, SE Spain. The crop was transplanted as 5 week old seedlings on 19 April 2010 and grown for 78 days. The crop was drip irrigated and fertigated receiving complete nutrient solutions in all irrigations. The crop was vertically supported with nylon cord. Four different N treatments were applied, commencing 23 days after transplanting (DAT), being NO_3^- concentrations of 2, 8, 15 and 23 m*M*; 0.4 m*M* NH_4^+ was applied in all treatments. The 15 m*M* NO_3^- was regarded as conventional management, the 23 m*M* as clearly excessive, and the 2 and 8 m*M* as N deficient. Total irrigation was 146 mm; and 34, 129, 241 and 373 kg N ha^{-1} were applied to the 4 treatments. Plot size was 6 m x 6 m with six rows of plants per plot and 12 plants per row; the plots were organised in a randomised block design with four replicate plots per treatment. The SPAD-502 chlorophyll meter (Konica Minolta Sensing, Inc., Japan) was used to estimate leaf chlorophyll content. The DUALEX 4 FLAV sensor (Force A, Paris, France) was used to estimate the content of leaf flavonols. Measurements were made at weekly intervals commencing 22 days after transplanting (DAT). All measurements were made on the most recently expanded leaf on 16 plants per plot, using the same plants within each plot. Five crop biomass samplings were made throughout the crop and the N content was determined. All data are means from four replicate plots. Sensor and biomass samplings coincided on 28, 43, 56 and 71 DAT.

3. Results & Discussion

The accumulation of biomass throughout the growing season was similar for the four treatments. There were appreciable differences in crop N uptake throughout the crop, the final total values being 119, 175, 220 and 254 kg N ha^{-1} for the 2, 8, 15 and 23 m*M* NO_3^- treatments, respectively, and in shoot N content (Figure 1) which were positively related to the applied N concentration. The ratio of leaf chlorophyll to leaf flavonols was strongly related to the applied N concentrations throughout the crop (Figure 2). There was a consistent general relationship between ratio of leaf chlorophyll to leaf flavonols and shoot N content (Figures 1 and 2). Linear regression analysis showed strong and significant ($P<0.01$) linear relationships between the ratio of leaf chlorophyll to leaf flavonols and shoot N content on 43, 56 and 71 DAT with coefficient of determination (r^2)

values of 0.78 to 0.85; however, the slope and intercept values varied appreciably between each of these dates indicating that the relationship was not constant over time. The average coefficient of variation for all values of the ratio of chlorophyll to flavonols was 29%.

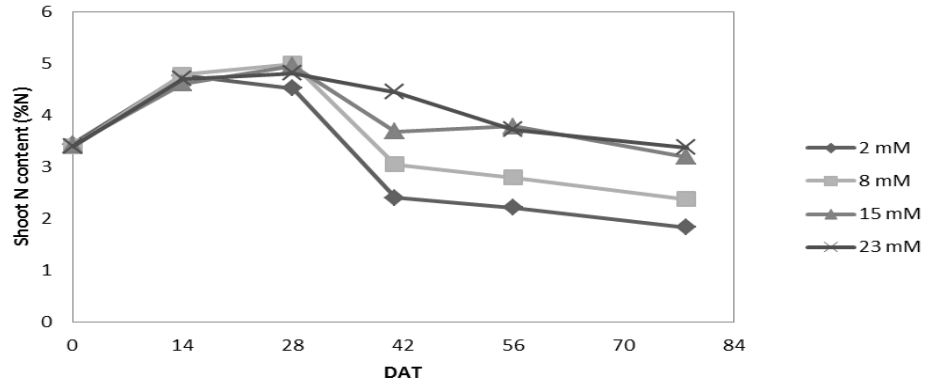

Figure 1. Shoot N content of melon crops receiving nutrient solutions with 2, 8, 15 and 23 m*M* NO_3^- throughout the crop after 23 DAT. All values are means of four replicates. DAT: days after transplanting.

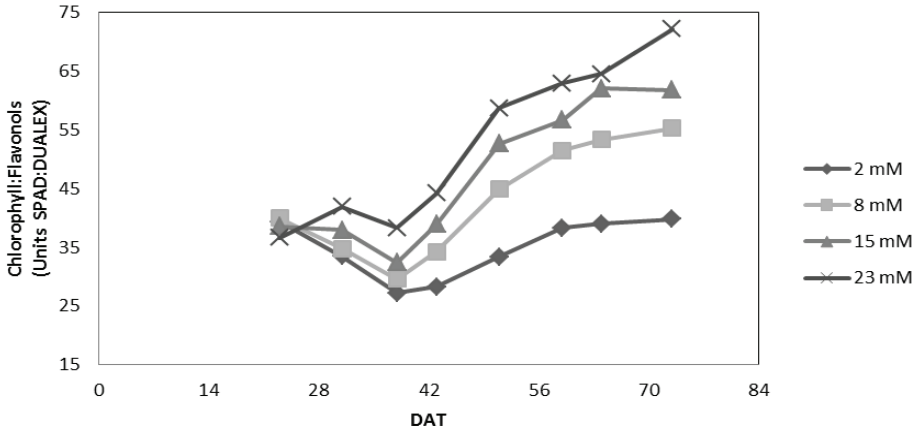

Figure 2. Ratio of leaf chlorophyll to leaf flavonoles of a melon crop receiving nutrient solutions with 2, 8, 15 and 23 m*M* NO_3^- throughout the crop after 23 DAT. All values are means of four replicates. DAT: days after transplanting.

4. Conclusion

The ratio of leaf chlorophyll to leaf flavonols, was sensitive to shoot N content. There was no consistent relationship between this ratio and shoot N content suggesting that threshold values for N management would need to be determined at particular growth stages for melon.

References

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